The Night Sky

The stars of the night sky have inspired people of all times and cultures. For example, the ancient people of the Mediterranean knew the group of bright stars shown in figure OV1.1 as Orion the Hunter. Such starry patterns are called constellations, and their outlines remain essentially the same for thousands of years. We see Orion the way it looked to the ancient Greeks.

To the people of long ago, the constellations were not only the subject of myths. They also served as markers of the passage of time, and although today many of us have lost contact with the night sky and its lore, the daily and yearly rhythms of the stars continue. For example, if we watch Orion on a midwinter night, we see it rise in the east (fig. OV1.2) and sweep overhead to set in the west.

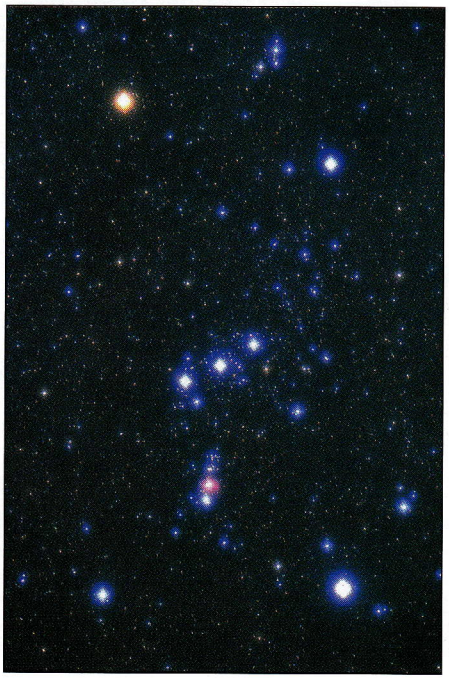


FIGURE OV1.1
Photograph of the constellation Orion.
(Roger Ressmeyer/Corbis.)

The motion of Orion and the other stars across the night sky is caused by the Earth's rotation. As our planet spins, it carries us beneath the sky so that the stars at night move across the sky from east to west just as the Sun moves during the day (fig. OV1.3).

The daily cycle of rising and setting is not the only cycle in the sky. If we watch the sky over the course of a year, we will notice that each season has its own constellations. Orion dominates the evening sky in January, but Leo the Lion replaces it by March. By June evenings, Leo is in turn replaced by Scorpius (fig. OV1.4). Thus, the constellations visible on a given night tell us the time of year.

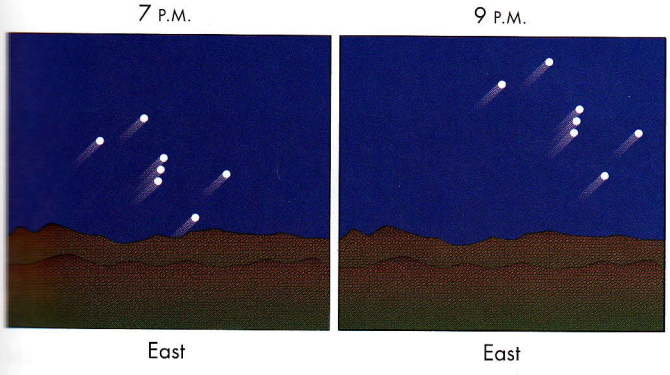
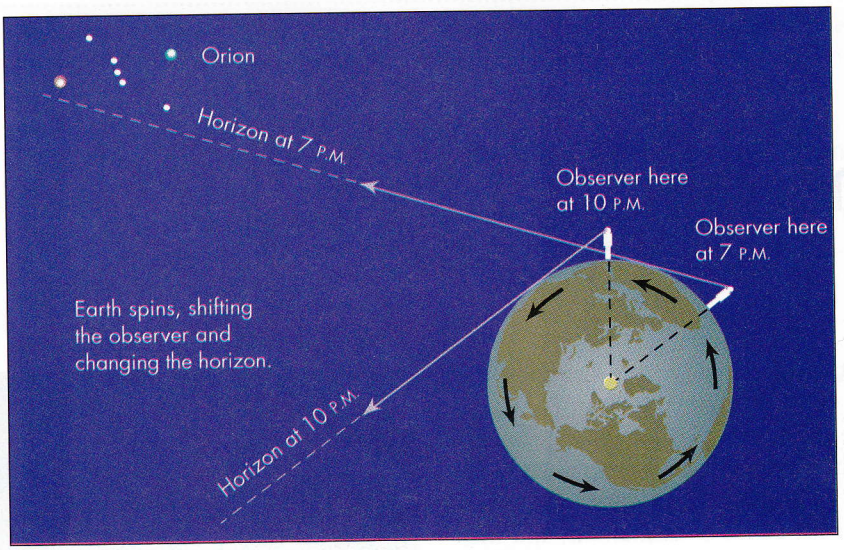
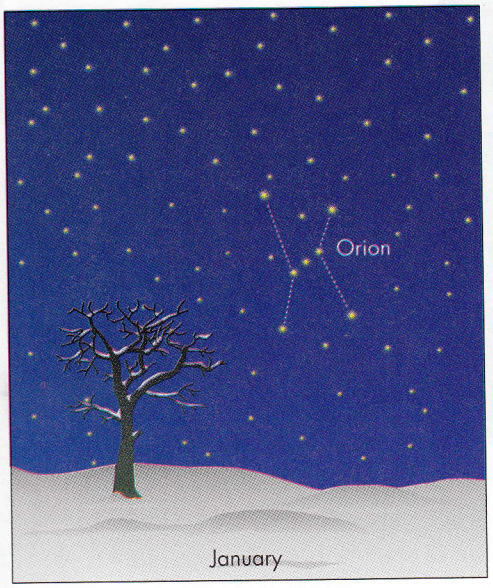


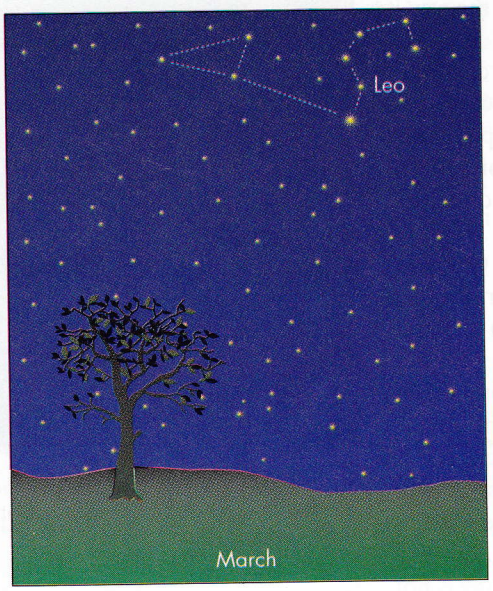
FIGURE OV1.2
Stars rise each evening in the east and move across the sky to set in the west.

FIGURE OV1.3
The stars rise and set because the Earth spins on its rotation axis.

Star rise and set caused by Earth's rotation







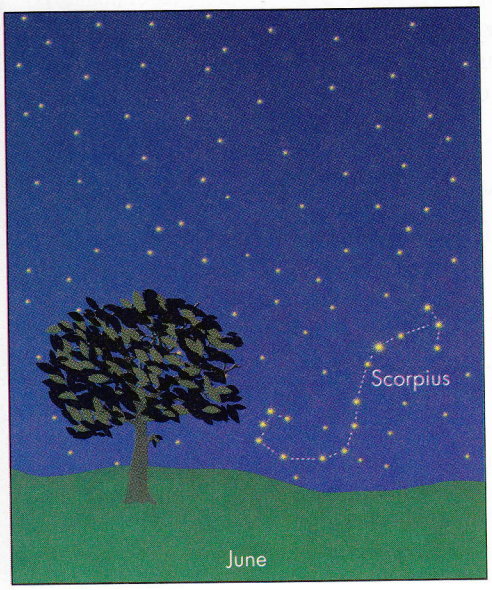


FIGURE OV1.4
We see different constellations at each season of the year. (Sky as seen looking south.)

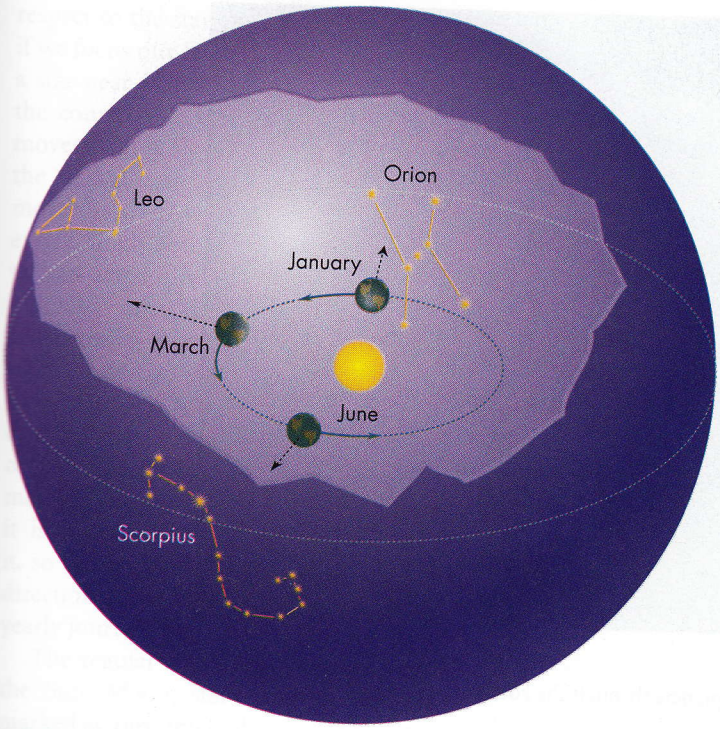


FIGURE OV1.5
We see different constellations as the seasons change because the Earth moves around the Sun, revealing parts of the sky previously hidden in the Sun's glare.

The changing constellations from season to season result from our planet's orbital motion around the Sun. As we circle the Sun, different parts of the sky move into and out of its glare—old constellations disappearing at sunset and previously hidden ones becoming visible at sunrise (fig. OV1.5).

Ancient people knew of other objects in the night sky in addition to the Sun and stars. All early people recognized the Moon and its monthly cycle of phases from crescent to full and back to crescent. In fact, markings on a 30,000-year-old bone may be a record of those changes (fig. OV1.6). Many ancient cultures also discovered five objects that looked like bright stars but that moved along well-defined paths through the constellations from one night to the next. The ancient Babylonians named them for their gods, names whose Roman versions we still use today: Mercury, Venus, Mars, Jupiter, and Saturn. To these original five planets astronomers have added three more—Uranus, Neptune, and Pluto—discovered with the help of the telescope.

Different constellations at different times of the year

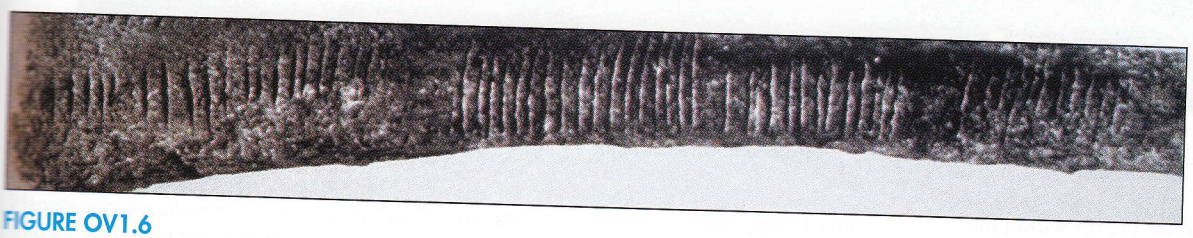


FIGURE OV1.6
Markings made on a bone fragment about 30,000 years ago may represent a record of the phases of the Moon.

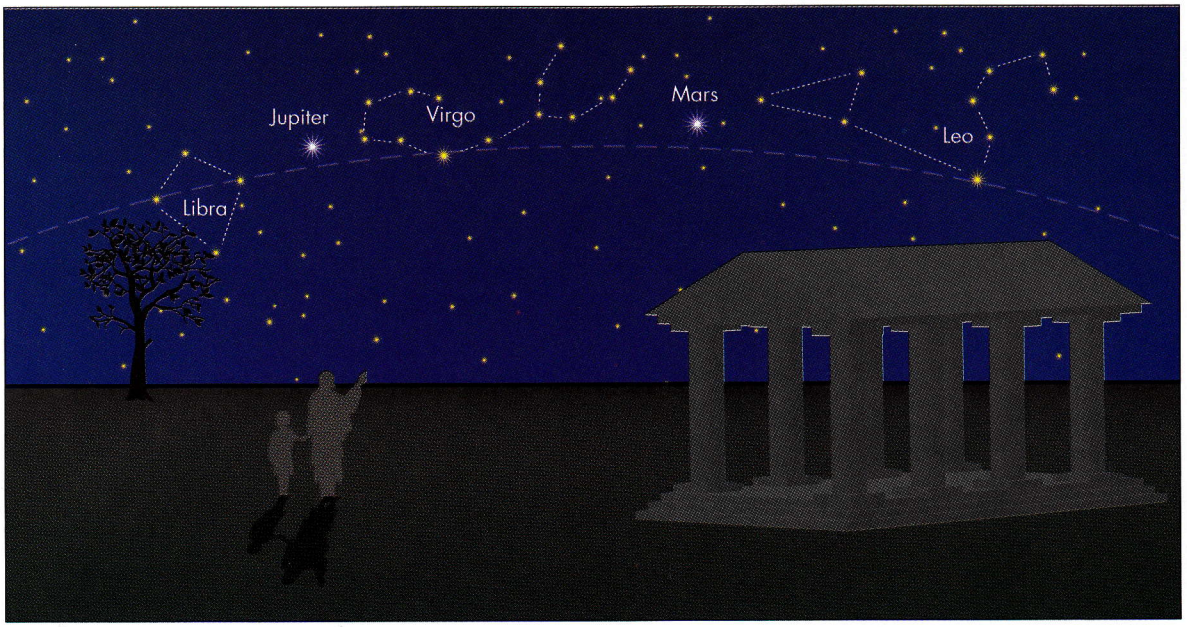


FIGURE OV1.7
The motion of the planets through the zodiac.

The daily, yearly, and other cycles of star and planetary motion led the people of the ancient civilizations surrounding the Mediterranean to picture the heavenly objects as pivoting around the Earth on giant crystalline spheres. The spheres were aligned so that the planets always moved within a narrow band on the sky that they called the zodiac (fig. OV1.7). Today we know that the planets follow the zodiac because their orbits all lie in nearly the same plane as the Earth's orbit (fig. OV1.8).

Careful observation of the planets shows a curious pattern. Because of their orbital motion around the Sun, planets move across the sky at a slightly different speed than the stars. Although the planets and stars *always* rise in the east and set in the west, the orbital motion of the planets makes them usually drift eastward with

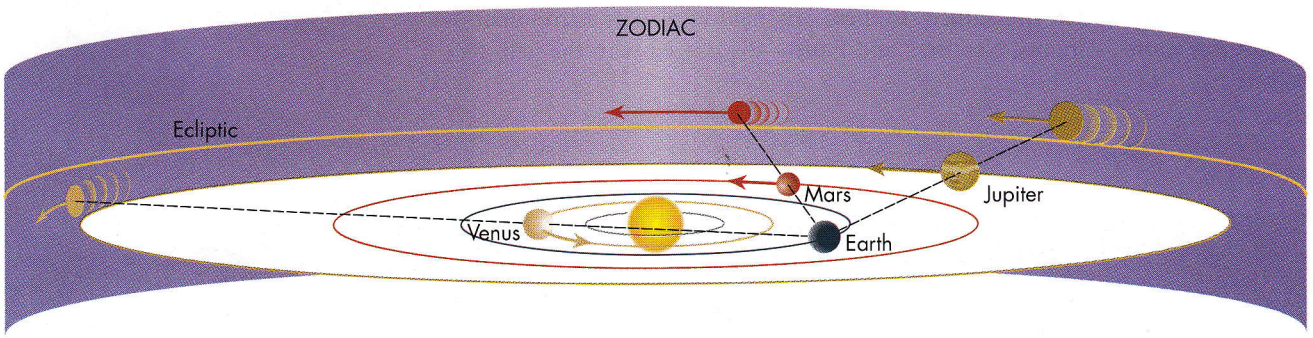


FIGURE OV1.8
The planets move across the sky within the narrow band of the zodiac because their orbits all lie in nearly the same plane.

respect to the stars (fig. OV1.9). That is, if we focus our attention on a planet and a star near it in the sky and watch over the course of several nights, the planet moves slightly slower across the sky than the stars do. As a result, the planet will move eastward with respect to the star, even though both are moving from east to west across the night sky.

This normal drift of the planets may sometimes reverse, so that a given planet shifts westward through the constellations (fig. OV1.10). This is not the result of the planet changing its direction in its orbit; rather, it is caused by the Earth's motion. Just as a car may briefly look like it is moving backward when you pass it, so too a planet appears to reverse its direction as the Earth swings by it in our yearly journey around the Sun.

The regular and predictable cycles of the Sun, Moon, stars, and planets are marked at rare intervals by eclipses. Astronomers of antiquity understood the cause of eclipses, and thousands of years ago, Greek and Chinese astronomers were able to predict these spectacular events. A lunar eclipse occurs when the Earth's shadow strikes the Moon, and a solar eclipse occurs when the Moon's shadow strikes the Earth (fig. OV1.11).

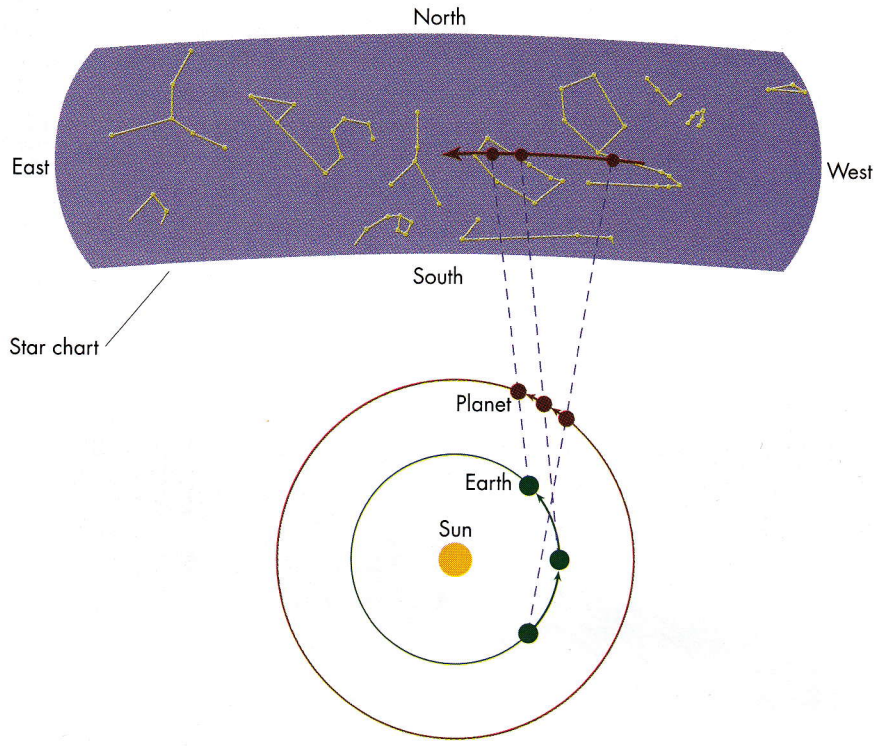


FIGURE OV1.9
From one night to another, the planets' orbital motion around the Sun normally carries them eastward against the background stars.

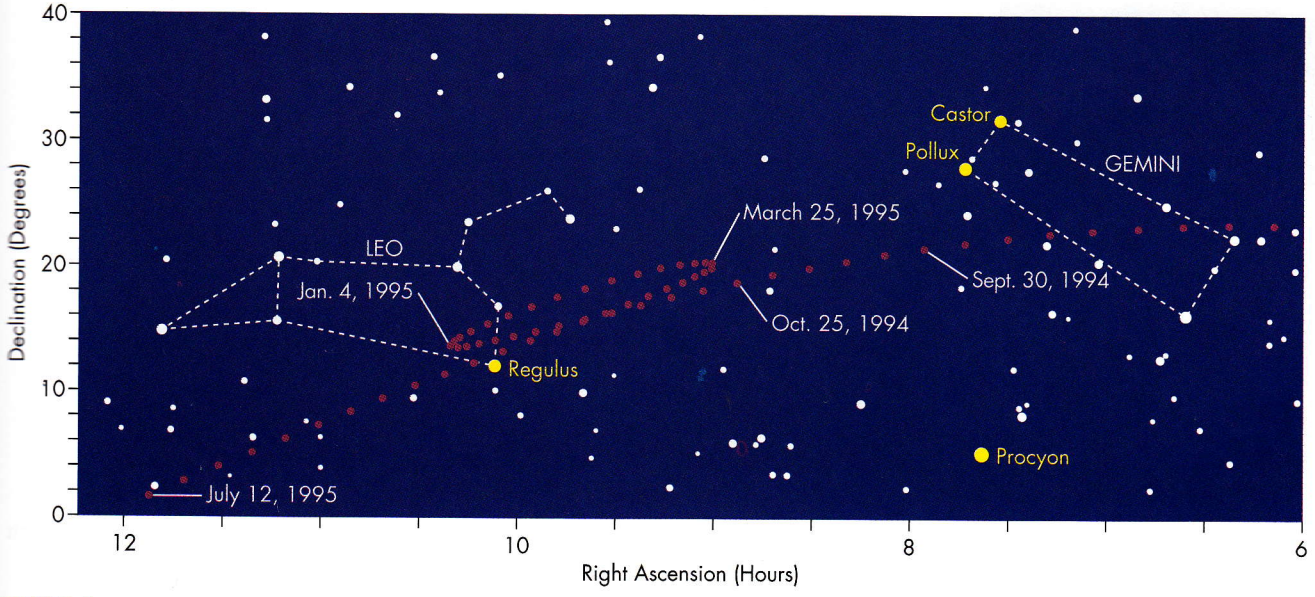


FIGURE OV1.10
Planets occasionally stop their eastward drift through the stars and for a brief period shift westward, undergoing retrograde motion. This "backward" drift is caused by the Earth passing the planet and does not mean the planet has reversed its orbital motion.

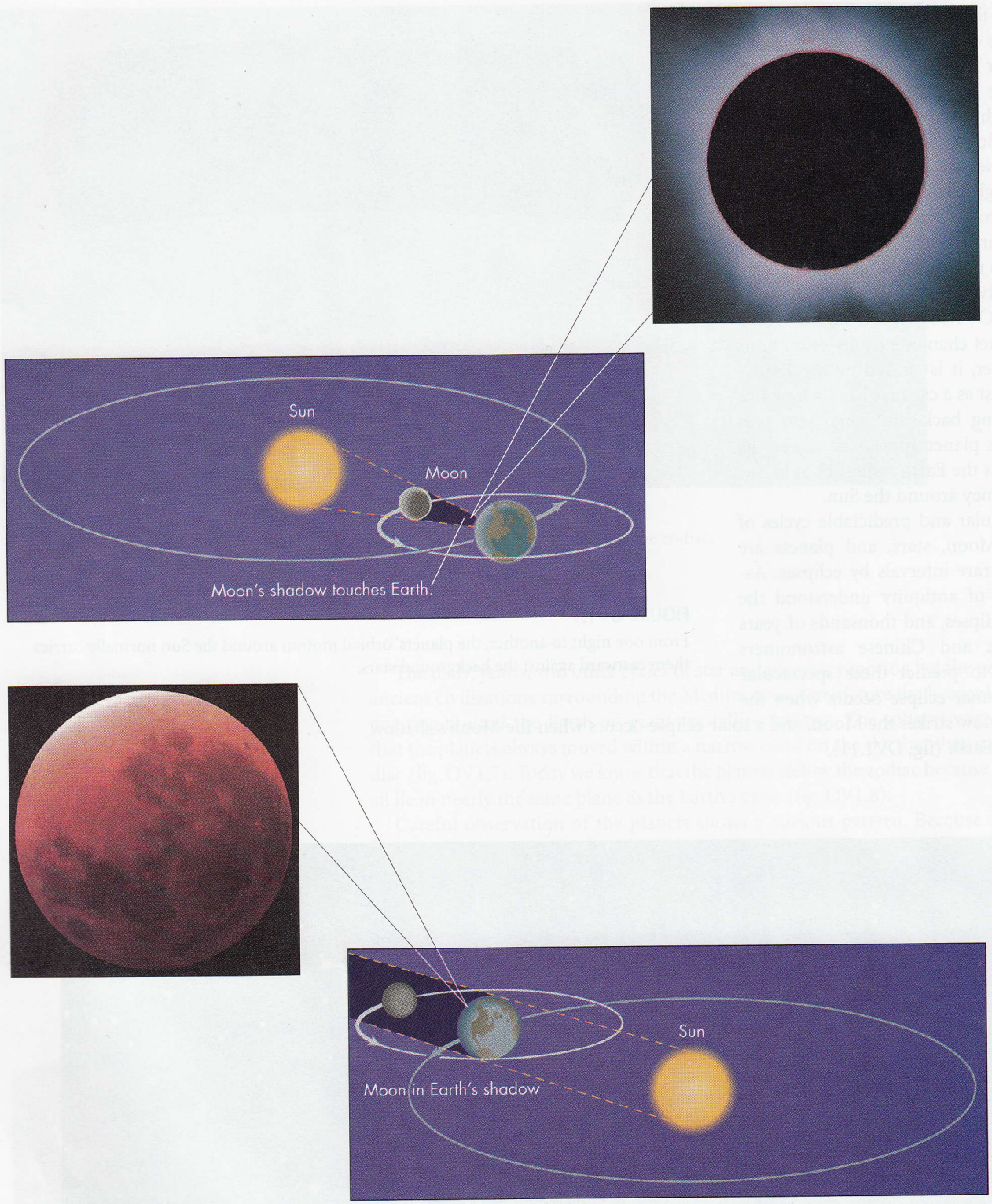


FIGURE OV1.11
When the Moon passes directly between us and the Sun, we see a solar eclipse. When the Earth passes directly between the Sun and the Moon, we see a lunar eclipse.
(Photos by Dennis di Cicco/Sky and Telescope.)

Although the Moon orbits the Earth once a month, the tilt of the Moon's orbit is such that in most months, the Moon's shadow falls above or below the Earth. Similarly, the Moon's orbital tilt causes the Earth's shadow to generally fall above or below the Moon. Under these circumstances, no eclipse occurs. However, twice each year, on the average, the Moon's orbit is tilted in just the proper way to permit the Moon's shadow to fall upon the Earth, and we then have an eclipse of the Sun. At such times, either two weeks before or two weeks after the eclipse of the Sun, we have an eclipse of the Moon.